PROJECT SUMMARY

OVERVIEW: We have assembled an interdisciplinary group of physicists, material scientist, mechanical engineer, and biologist in order to develop a multi-functional water Cherenove detector for the study of material compatibility, the contamination and environmental monitoring and control, and benchmarking the simulations for the Long-Baseline Neutrino Experiment (LBNE). The project will take a progressive first-of-its-kind design approach, allowing scientists, engineers, and students to develop and optimize the cleanliness and environmental control protocols and experimental methodology for the LBNE.

This instrument will be a 2000:1 scale down of the 200 kilo-ton LBNE water Cherenkov vessel, incorporating a pico-second pulse laser diode, fast photon detectors, a muon hodoscope, sensitive flow and temperature meters, and dust and contamination sample collectors. The finished instrument will incorporate a stable water circulation system and a dedicated cleanroom to allow long observation times commensurate with the degradation processes. The instrument will be working at several wavelengths and continuous Cherenkov light spectrum to exploit the use of different materials in extra pure water, the contamination and environmental parameters and their impact on the signals in the water volume. The instrument will have several unique features, including precise timing and waveform information at various wavelengths, flexible settings of various contamination levels and environmental parameters, and the capability of collecting samples in the sensitive volume for further analysis.

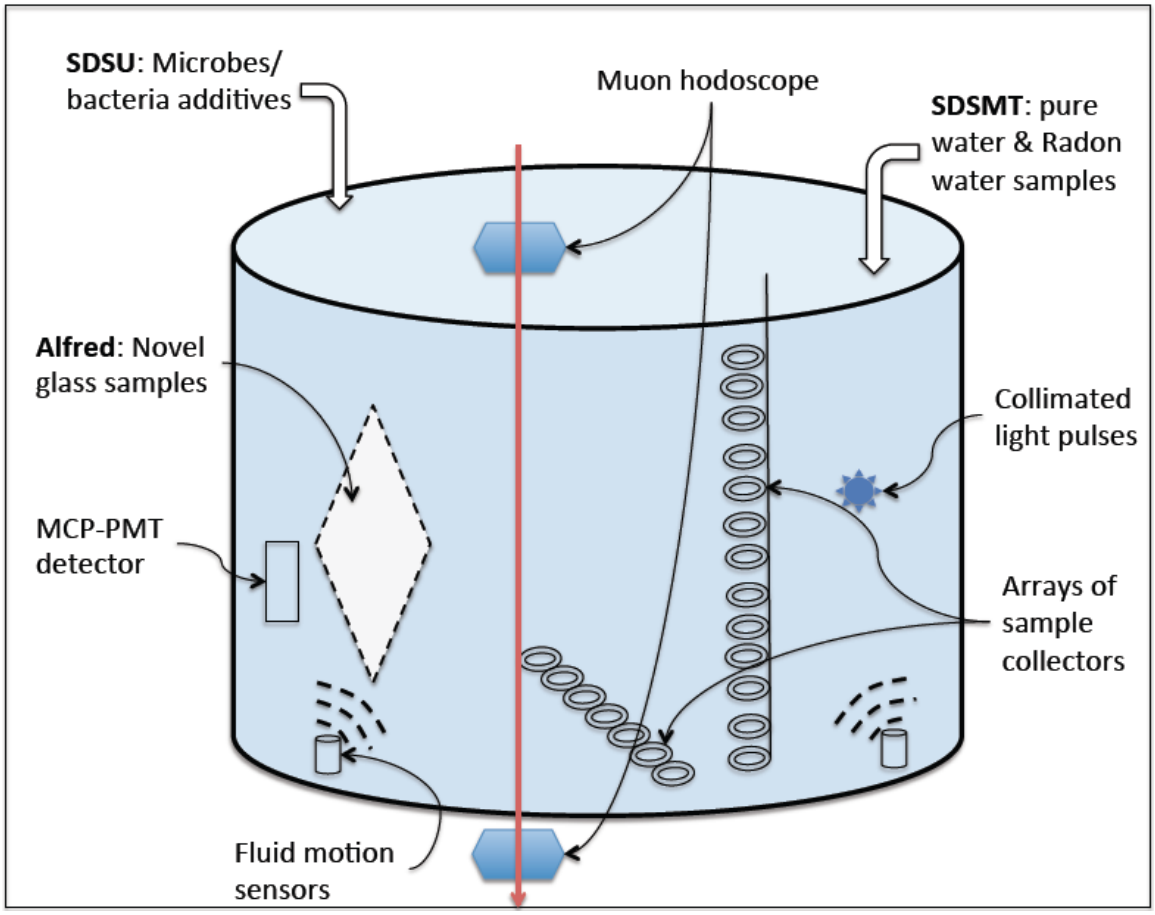
INTELLECTUAL MERIT: A detailed study of the contamination and environmental monitoring and control is essential to guarantee the LBNE science goals at lower energies, including solar neutrinos, geoneutrinos, supernova physics, and relic neutrinos. The team assembled for this project brings the necessary expertise to capitalize on the scientific and engineering opportunities that will become enabled by the proposed instrumentation and the studies during the project. The instrumentation developed will enable comprehensive studies to:

(1) Estimate the cleanliness requirements in a small version detector and their dependence on flow pattern, dust deposition, and contamination migration in water and other fluids.
(2) Test properties of materials in pure water and other fluids over extended period of time, for example the new glass samples for photon sensors.
(3) Study bacterial/bio growth in water, especially on optical components and surfaces.
(4) Test sensors for monitoring of fluids in real-time.
(5) Correlate the fluid parameters (e.g., chemistry, temperature) and optical performance and identify
(6) Benchmark detector simulation by optics calibrations with emphasis on a downscaled integrated system.

The instrument design and the results will be published, thereby advancing the experimental neutrino physics community. With minor upgrades, the instrument can also support further study of additives in fluids, which is extremely valuable for next generation particle detectors to reach high sensitivity and better performance.

BROADER IMPACT: The most promising candidate site for the LBNE far detector is in the Homeskate mines in South Dakota. The construction of this huge facility will require significant amount of local support. Nevertheless, South Dakota has a rather small experimental neutrino physics community. The proposed work will support physics, biology, and mechanical engineering programs in two major public colleges in South Dakota by enabling collaborative research opportunities for students and faculty. This project provides interdisciplinary training and research opportunities, providing graduate level training to students in the region.

SDSM&T also maintains a permanent Native American outreach program, serving the nearly 70,000 Native Americans in South Dakota. The PIs involved strongly support these efforts and would utilize the instrumentation in outreach programs aimed at recruiting under-represented groups into science and engineering via their institutions.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